SECTION 34 21 50

COMMON MATERIALS AND METHODS FOR TRACTION POWER

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Meters and Relays

B. Transducers

C. Switches

D. Wires and Cables

E. Raceways

F. Wiring Devices

G. Indicating Lights

H. Buses and Connections

I. Miscellaneous Devices

J. Factory Testing

1.02 MEASUREMENT AND PAYMENT

Not used

1.03 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI C12.1 Electricity Metering
2. ANSI C37.90 Relays and Relay Systems Associated with Electric Power Apparatus
3. ANSI C37.90.1 Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems
4. ANSI C39.1 Requirements for Electrical Analog Indicating Instruments
5. ANSI C57.13 Requirements for Instrument Transformers

B. American Society for Testing and Materials (ASTM):

1. ASTM B766 Electrodeposited Coatings of Cadmium

2. ASTM E84 Standard Test for Surface Burning Characteristics of Building Materials

C. Institute of Electrical and Electronics Engineers (IEEE):

1. IEEE 383 Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations

D. National Electrical Manufacturers Association (NEMA):

1. NEMA FG 1 Fiberglass Cable Tray Systems

2. NEMA VE 1 Metallic Cable Tray Systems

E. National Fire Protection Agency (NFPA):

1. NFPA 70 National Electrical Code

F. Underwriters Laboratories Inc. (UL):

1. UL 94 Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.04 SUBMITTALS

A. General: Refer to Section 01 33 00, Submittal Procedures, and Section 01 33 23, Shop Drawings, Product Data, and Samples for submittal requirements and procedures.

B. Submit:

1. Short circuit force calculations for parallel 1000 Vdc system positive and negative conduits.

2. Data sheets for conduit support bracing.

1.05 QUALITY ASSURANCE

A. Electrical components, devices, and accessories shall be listed and labeled in conformance with NFPA 70, Article 100. Electrical components, devices, and accessories and their installation shall comply with NECA's National Electrical Installation Standards (NEIS).

1.06 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be weatherproofed for shipment. Connection openings shall be closed to prevent entrance of foreign material during shipment and storage.

B. Equipment shall be handled and stored in conformance with manufacturer's instructions. One copy of these instructions shall be included with the equipment at time of shipment.

PART 2 – PRODUCTS

2.01 METERS AND RELAYS

A. Metering and relaying devices, and similar devices shall be provided, wired, and connected as indicated.

B. Additional components, such as auxiliary relays, isolating diodes, and other devices not indicated but required for a complete fully functional system, shall be furnished and installed.

C. Each relay and device shall have a sealed dust cover, which shall keep the inside of the case free of dust and moisture.

D. Protective devices provided shall prevent damage to the individual parts of the equipment due to short-circuit, loss of cooling, transient voltage conditions and overloads.

E. All protective relays in the ac switchgear and dc switchgear shall be solid-state type. Control and auxiliary relays shall be electro-mechanical type. Solid-state type auxiliary relays are acceptable provided their output contacts, if required to interface with other systems such as SCADA, are independent and potential free:

1. Unless stated otherwise, relays requiring control power shall be able to operate properly with station battery voltage of 125 V dc, with fluctuations of plus or minus 10 percent.

2. All relay contacts shall be properly rated for the intended duty, and shall meet the required performance with no less than 50 percent spare margin at the expected worst-case operating condition.

F. All protective relaying shall be provided with separate contacts for each operating element, and shall have indicating targets to show operation of the relay element. Drawout type relays shall be installed in their cases prior to final inspection and shipment.

G. All protective devices shall be coordinated to prevent false tripping or malfunction, to protect against damage to equipment, property, and personnel, and to assure continuity of operation.

H. Relays and devices suitable for semi-flush mounting shall be of the flexitest-type or of the drawout type with flat black finish and shall be mounted on panels or doors.

I. Relays and devices not suitable for semi-flush mounting shall be surface mounted to mounting brackets on panels within enclosures or on the inside of the doors.

J. Indicating instruments shall be semi-flush mounted on the front panels and shall have LED readouts.

K. Relays and devices in which any of the elements are subjected to 1000 V dc potentials shall be mounted on an insulating base inside the high voltage compartment.

L. Relays shall be of the ASEA Brown Boveri Corporation, Westinghouse, General Electric or approved equal.

M. Lockout Relays:

1. Lockout relays shall be high-speed, multi-contact, hand reset type with oval handles and mechanical targets which indicate whether the relays are in the tripped or reset position.

2. Lockout relays shall be General Electric Type HEA, Westinghouse Type WL, or equal.

N. Interposing (Auxiliary) Relays:

1. Interposing (auxiliary) relays shall be plug-in type and include dust covers and be rated for 10 amperes.

2. Relay coil shall be able to pickup by momentary contact closure of 300 ms and its contacts shall stay closed until the breaker or the end device completes its operation. If operation is not completed within the normal time, the relay coil shall reset automatically.

3. Contractor shall coordinate the duration of the remote control signals from BART's OCC with the pickup times of the interposing relays in the substations to ensure the remote commands do reach and activate the end device of the intended equipment.

O. Meters: All meters shall be switchboard type for semi-flush mounting. The cases shall be dust tight, with dull black finish, and covered with a non-reflecting glass window:

1. Ammeters, wattmeters, watthourmeters, varhour meters and voltmeters shall be solid-state type with digital LED readouts that cover the full range of operation including overload conditions. The LED readouts wattmeters, watthour meters and varhour meters shall be able to read nine digits and self-reset to zero after maximum reading is reached. The ammeters and voltmeters shall be able to read six digits.

2. The accuracy of all indicating instruments shall be within one-half percent of the actual value. The indicating instruments shall have true RMS sensing.

3. AC voltmeters shall be rated for 150 V input voltage, and shall be appropriate for use with 20125 V to 115 V potential transformers. The calibration shall be in

line-to-line voltage. DC voltmeters shall receive inputs from voltage transducers as specified. Input voltage range to the transducers shall be 1500 V.

4. AC ammeters shall be rated for operation with the connected current transformers. DC ammeters shall be rated for use with metering shunts, as indicated. Ammeters shall be properly protected to prevent damage due to the flow of maximum available short-circuit current in the primary system.

5. Ammeter and voltmeter switches to monitor the three-phase ac current and voltage, respectively, shall be provided.

6. Wattmeters shall be rated 1 mA for connection to wattmeter transducers.

7. The watthour and varhour meters shall have drawout construction and shall be transformer rated, 120 V, 5 A, with suitable range equal to the associated potential and current transformers. The meters shall be furnished with an accumulator.

2.02 TRANSDUCERS

A. General: Except for the AC watt-hour and var-hour transducers specified in Article 2.02D below, and the isolation transducer for the DC MPR, output range of all transducers shall be either 4 to 20 mA, or 0 to 5 V signals.

B. AC Current Transducers:

1. Operating input range shall be single phase, zero to five amperes, 60 Hz with overload capability of 20 amperes continuous and 250 amperes for one second.

2. Burden shall not exceed 2.0 VA at 60 Hz.

C. AC Voltage Transducers:

1. The nominal input voltage to each ac voltage transducer shall be single phase, 120 V, 60 Hz. The operating input range shall be 0 to 150 V ac with continuous overload capability to 180 V ac.

2. Burden shall not exceed 2.5 VA at 120 V ac, 60 Hz.

3. The maximum allowable error shall not exceed plus or minus one quarter of a percent of full scale at 25 degrees Celsius. AC output ripple shall not exceed one percent.

4. The error resulting from a temperature variation between minus 20 degrees Celsius. and 60 degrees Celsius. shall not exceed plus or minus one half percent of full scale.

5. The unit shall be provided with a 10 percent of full-scale calibration adjustment. The response time shall be 400 ms or better from 0 to 99 percent.

6. The unit shall withstand a dielectric test of 1500 V RMS.

D. AC Watthour and Varhour Transducers:

1. The potential input to the watthour and varhour transducers shall be 120 V ac, 60 HZ nominal, 0 to 150 V operating range, 180 V overload and 4 VA burden at nominal voltage.

2. The current input shall be five amperes nominal, 0 to 20 amperes operating range, 250 amperes overload for one second and 0.25 VA burden.

3. The maximum allowable error shall not exceed plus or minus 0.2 percent of full scale at 25 degrees Celsius. The transducer shall be provided with a 10 percent of full-scale calibration adjustment. The full-scale calibration shall be rated in accordance with the instrument transformer (potential or current) ratios.

4. The response time shall be 400 ms or better from 0 to 99 percent range.

5. Signal from transducers shall be pulses that can be sensed by a SCADA discrete input module. Transducers shall be calibrated so that each pulse represents a given number of KWH or KVARH units. Pulse rate at normal full load shall not exceed one pulse per second. Pulse duration shall be more than 100 ms and less than 150 ms.

E. Temperature Transducer:

1. The temperature input range shall be coordinated with type of Resistance Temperature Detector (RTD) supplied with the rectifier transformer.

2. The output range shall be suitable for the temperature class of the rectifier transformers.

F. DC Voltage Transducers:

1. DC voltage transducers shall be insulated for operation at 4600 V dc for 1 minute. The operating input range shall be 0 to 1500 V dc.

2. The maximum allowable error shall not exceed plus or minus one half percent of full scale at 25 degrees Celsius. Temperature coefficient shall not exceed plus or minus 0.04 percent per each degree Celsius. Load resistance variations from 0 to 10, 000 ohms shall affect the output current no more than 0.1 percent.

3. The input circuit shall be completely isolated from all other circuits and grounds. The output circuit shall include internal filtering.

4. Zero and gain adjustments shall be accessible from outside the case.

2.03 SWITCHES

A. Control and Selector Switches:

1. Control and selector switches shall be rotary, cam-operated, multi-stage type, suitable for switchboard mounting with a rectangular, front panel engraved

escutcheon plate showing the switch positions. The switches shall be Westinghouse type W-2, or General Electric type SB-1, or approved equal.

2. Control switches shall have the following types of handles:

   a. Circuit breaker control switches shall have pistol-grip handles.

   b. Instrument selector switches shall have round knurled handles.

   c. Lockout relays and local-remote transfer selector switches shall have oval handles.

3. Switch contacts shall be silver-plated, self-cleaning, readily renewable type, and shall have adequate insulation and contact surface. Switches shall be installed so that mating contact surfaces are parallel.

4. Breaker control switches shall be spring-return to neutral type with pull and lockout position, and shall be furnished with mechanical indicating devices (red and green target) to show the last operation of the switch.

5. The Contractor shall determine the number of stages and contact wiring arrangement for each switch, depending on the application. Each switch shall be provided with at least two spare stages.

6. Switches shall be rated for a mechanical life of not less than 500,000 operations. Electrical ratings shall be 600 V, 20 A continuous.

7. Tight-fitting dust covers shall keep the operating and contact parts of the switches clean.

B. Test Switches:

1. Test switches shall be provided for all ammeters and voltmeters, and between all instrument transformers and the protective relays supplied by these transformers.

2. Each test switch group shall be mounted in a semi-flush case of uniform size, capable of holding at least six current positions and four voltage positions. A convenient, dull black cover shall permit covering the test switches and contacts when they are not in use.

3. At the switching stations, test switches in current transformer circuits shall be seven-pole, with three straight test jack assemblies, one through bar, and three single-pole current assemblies, left hand, working as one unit.

4. Test switches for the current transformers shall be of the type that do not disturb the permanent wiring and do not interrupt the current transformer circuit when the switch is used

5. The test switches shall be specifically designed for use in AC instrumentation circuits, and shall be UL listed. Test switches shall be by States, Superior, Meter Devices, or approved equal.

2.04 WIRES AND CABLES

A. Low voltage power and control wiring and cables shall have insulation rated for continuous operation at 600 volts minimum. Refer to Section 26 05 24, Low Voltage Wires and Cables, for the requirements for 600-volt single and multiple conductor power and control cables, fixture wires, thermocouple cables, color-coding of conductors, cable supports and fasteners, and conductor bundling straps. Additional requirements shall be as follows:

1. Switchboard wiring shall be type SIS.

2. Wire that crosses hinged joints shall be flexible Class C stranded copper, hinge-type wire.

3. Cables shall have the manufacturer, type of insulation and voltage class identified by continuous labeling, which shall remain legible for the life of cable under normal use in service.

4. Cables shall pass the flame propagating criteria of IEEE 383 and shall have a minimum circuit time of five minutes in the flame test of IEEE 383. Type test certificate shall be included with every shipment of cables.

B. High Voltage Control Power Cables:

1. High-voltage control power cables used for control and instrumentation circuits exposed to the 1000 V potential shall be as specified in Section 34 22 23, Traction Power Cables.

2. The termination accessories shall be furnished in the form of a kit and shall include complete instructions.

C. Terminal Connectors and Insulating Tapes. Refer to Section 20 70 26, Common Materials and Methods for Electrical Systems, for the requirements concerning terminal connectors and insulating tapes. Exception to the quoted requirements shall be: termination fittings for No. 10 and smaller conductors shall be screw-on, spring pressure type copper connectors with nonflammable, self-extinguishing insulation of temperature rating equal to that of cable being connected. Terminals shall provide a metal grip on the conductor insulation for strain relief. Wire nuts are prohibited.

2.05 RACEWAYS

A. Requirements for interior conduits, fittings and accessories; conduit hangers; inserts; outlet, junction, and pull boxes shall be in accordance with Section 20 50 13, Raceways for Facility Services.

B. Where interior or exterior GRS conduits containing 1000 Vdc system positive and negative cables are installed within one foot of each other, or in parallel with GRS grounding system conduits, provide conduit bracing of sufficient strength to inhibit distortion due to mechanical forces generated by dc system faults of 100,000 amperes. Submit calculations showing forces expected during a fault, and product data sheets for conduit bracing to be used.

C. Cable Tray Systems. Requirements for cable tray systems shall be in accordance with Section 20 50 13, Raceways for Facility Services, except for the following modifications:

1. Cable trays shall be ladder-type.

2. In areas less than five feet from high resistance grounded equipment, cable tray system shall be of fiberglass reinforced polyester (FRP) in accordance with NEMA FG-1, UL 94 and ASTM E84, Class 1 Rating.

3. Fastening hardware (bolts, nuts, etc.) for trays and support bracket shall be steel, cadmium plated in accordance with ASTM B766.

4. Dimensions:

   a. Straight sections and fittings shall have inside clear width as indicated, measured between the rails. Overall width shall not exceed inside width by more than two and a half inches. Inside nominal depth shall be 4 inches. Overall tray depth shall not exceed inside depth by more than three-fourths inch.

   b. Rung spacing for ladder-type straight sections shall be nine inches on centers maximum.

5. Raceways external to traction power facilities shall be in accordance with Section 20 50 16, Underground Ductwork and Structures for Facility Services, and Section 20 50 13, Raceways for Facility Services.

2.06 WIRING DEVICES

A. Toggle switches, receptacles, and associated covers, shall comply with the requirements of Section 20 70 26, Common Materials and Methods for Electrical Systems.

B. Terminal Blocks:

1. Terminal blocks shall be 600 volt, heavy-duty, screw washerhead type with laminated phenolic dust covers and adhesive-backed marking strips to indicate the wire numbers.

2. Current and potential transformer secondary leads shall be wired directly to the terminal blocks before wiring them to the relaying, metering or control devices.

3. Terminal blocks for current transformer leads shall be of the short-circuiting type.

4. The common secondary of the current and potential transformers shall be grounded with No. 8 AWG wire running directly to the ground bus without intervening splices or terminal blocks.

5. Terminal blocks shall be grouped by cable designation and segregated according to the circuit voltage.

6. Identification of terminal blocks and terminal points shall be alphanumeric with each terminal block having a unique identification.

7. Each terminal block or terminal block group shall have at least 20 percent spare points.

2.07 INDICATING LIGHTS

A. Indicating lights for equipment in the traction power facilities shall be based on light emitting diode (LED) lamps. The LED lamps shall be replaceable, with built-in resistor and high dielectric strength for reverse voltage protection. The LED lamps shall be:

1. Suitable for use with 125 V dc control system voltage;

2. Capable of operating over a voltage range from +15 percent to –30 percent of the nominal;

3. Designed with bayonet bases;

4. Mounted in compact, rugged sockets; and

5. Readily replaceable from the front.

B. Lenses and bezels shall be rectangular or circular, one and three-eighths inch maximum width and height and shall permit reading from oblique angles.

C. LED’s shall be rated for 100,000 hours at full voltage, and shall be clearly visible at an angle of 30 degrees and at a distance of 15 feet in a fully lit environment.

2.08 BUSES AND CONNECTIONS

A. Buses shall be made of round edge rectangular, high conductivity, rigid copper bars and shall be of sufficient size to carry the continuous rated current, without exceeding the temperature limits indicated in the applicable ANSI, NEMA, and IEEE standards for the specific equipment.

B. The buses shall be supported and braced between each other and to the enclosure with high strength anti-hygroscopic, flame retardant, non-tracking insulators, so that the buses can withstand the thermal and mechanical stresses due to short-circuit currents equal to the maximum symmetrical interrupting and three-second short time current ratings of the circuit breaker protecting the bus.

C. Bus taps and connections shall be welded or bolted:

1. All bolted bus connections shall be acid etched and plated with electro-deposited silver after buses have been bent or formed. Bending after the plating process is not allowed.

2. Bolted connections shall utilize Bellville-type washers and high strength, rust resistant steel bolts, such as cadmium-plated or galvanized. Bolts shall pass

through the bus bar conductors, and shall be capable of being properly torqued and locked in place, to provide and maintain full and uniform pressure under all operating conditions.

D. Bus joints shall have conductivity at least equal to that of the bus bar, and each joint shall be so clamped that no loss of conductivity will occur during the life of the equipment.

E. Access plates shall be provided to permit assembling joints and inspecting all bolted connections after installation of the bus enclosure.

2.09 MISCELLANEOUS DEVICES

A. Space Heaters: Thermostatically- and humidistatically-controlled space heaters shall be provided in all enclosures, and in separate compartments within enclosures, to keep the equipment temperature above the dew point and avoid condensation. Space heaters shall operate from the 120 V, single-phase, 60 Hz supply, and the circuits shall be protected by circuit breakers. Space heaters shall be provided with laminated phenolic nameplates. For additional requirements refer to Section 23 81 00, Unitary HVAC equipment.

B. Current-Limiting Fuses: current-limiting fuses or current-limiting resistors shall be installed in all 34.5 kV ac and 1000 V dc control and instrument circuits at the points of supply:

1. Fuse mounts shall be porcelain, bakelite or molded phenolic base, with appropriate voltage rating so that the fuse mount does not represent a weak point on the overall insulation system.

2. The fuses and resistors shall be housed in an enclosure made of electrical-grade laminated phenolic having a minimum wall thickness of one fourth of an inch and covering all live terminals.

3. The fuses shall be readily accessible, and shall not obstruct or be obstructed by any other equipment.

C. Current Shunts: current shunts shall be used to provide dc millivolt signals as input to current measuring instruments and relays, as indicated. Current shunts shall be of rugged design and suitable for in-line busbar mounting. Shunt output shall be 50 mV nominal, with accuracy plus or minus 0.25 percent. The Contractor shall determine the current rating of the shunt, as suitable for the application.

2.10 FACTORY TESTING

A. General: Testing shall be performed in accordance with the requirements of Section 01 45 24, Testing Program Requirements.

B. Test Types: Unless otherwise indicated, design tests on common materials and methods for traction power that are standard products of manufactures, or off-the-shelf items, are not required. Production tests shall be performed in accordance

with the requirements defined herein, and as needed to ensure a correctly assembled and properly functioning installation.

C. Relays, Meters, Transducers and Instrument Transformers:

1. Relays, meters, transducers and instrument transformers shall be tested in the factory for accuracy, performance, operation, and correct setting and calibration, per ANSI C12.1, ANSI C37.90, ANSI C39.1 and ANSI C57.13. The Contractor shall be responsible for relay coordination.

2. Relay and transducer testing, setting, and calibration shall be separately bench-tested from the overall inspection and testing. Relays and transducers shall be tested in accordance to ANSI C37.90.1 for surge withstand capability, except where certified test reports are available for the same model to prove that such tests have been passed successfully by identical equipment.

3. Test current and voltage shall be injected into the current and voltage circuits at the instrument transformer terminals to ensure that the protective relays are polarized correctly and trip the respective circuit breakers as designed, and to ensure that instruments read correctly and meters are calibrated accurately.

4. Instruments and transducers shall be checked for accuracy at quarter, half, three-quarters and full-range points.

5. After the relays have been calibrated with the proper settings, a small white card stating the settings and date of calibration shall be placed in the relay case.

D. Low Voltage Wiring:

1. The Contractor shall verify in the factory that the wiring conforms to the approved control schematics and wiring diagrams. Wiring continuity and proper termination shall be checked completely, including interconnections at shipping splits.

2. All wiring within equipment enclosures, and among equipment enclosures shall be tested as described below:

   a. All wiring shall be checked for accuracy, intended functionality, ground connections, and insulation integrity by means of high potential, continuity, and operations tests.

   b. All 1000 V dc wiring shall be given a high-potential test of 4600 V, 60-Hz voltage to ground for one minute. All other low voltage wiring shall be subjected to 1500 V, 60-Hz voltage to ground for one minute.

   c. Insulated cables and wires shall be certified to have passed the design and production test in accordance with the applicable ICEA, IEEE and NEMA standards, including the flame propagation test.

E. Cable Tray Design Test Requirements:

1. When tested in accordance with the load test procedures described in NEMA VE 1, a max span of eight feet including a static concentrated load of 200 pounds shall support the following loading, with a safety factor relative to the destructive load, regardless of the type of splice plates or type of span: cable tray of 30 inches wide or less, shall support a total cable load of 55 pounds per linear foot; and cable trays over 30 inches wide shall support a loading of 88 pounds per linear foot.

2. Straight sections and fittings shall not permanently deform under a 200-pound static concentrated load applied vertically along a four-inch length under both of the following conditions:

   a. Load applied to one side of a tray section having specified cable weight and support spacing, at midpoint between supports over splice connection

   b. Load applied to one rung of empty tray section having specified support spacing, at midpoint between side rails and supports

PART 3 – EXECUTION

3.01 INSTALLATION

A. Installation of common materials and methods for traction power shall conform to the recommended practices of the applicable ANSI, IEEE and NEMA standards; shall be in accordance with the accessibility, clearance, conformity, and arrangement requirements of Section 34 21 70, Traction Power Facilities Installation Requirements, and as indicated.

END OF SECTION 34 21 50